Tybouts Corner Landfill | Stand File

HYDROLOGIC STUDY OF SANITARY LANDFILL

FOR

NEW CASTLE COUNTY, DELAWARE

by

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A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Civil Engineering.

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CHAPTER II

GEOLOGIC FORMATIONS AND GROUND WATER OCCURRENCES

IN NORTHERN NEW CASTLE COUNTY

II-1. INTRODUCTION

Since the purpose of this study is concerned primarily with the hydrologic factors of sanitary landfill operation affecting ground water contamination, no attempt has been made to treat the geologic fo[illegible] the study area in detail. A brief description of regional geology is given in this chapter to comprehend the occurrence, yielding ability, and wat[illegible] of the geologic formations in northern New Cas[illegible] para- meters are significant hydrogeological factors for a sanitary landfill operation.

II-2. GEOLOGIC REGIONS

The land mass of northern New Castle County lies in two major geologic provinces -- the C[illegible]l Plain and the Piedmont. The sedimentary de[illegible] the Coastal Plain are gently dipping sands, clay[illegible]d gravels which extends beneath the ocean. Inland [illegible] the Coastal Plain

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CHAPTER V

EXPERIMENTAL STUDY OF TYBOUTS CORNER SANITARY LANDFILL

V-1. PROJECT OPERATION CONDITIONS

In November 1968, the Department of Public Works, New Castle County selected Tybouts Corner, the intersection of U. S. Routes 13 and 301 as shown by Figure 12, as a new site for sanitary landfill to manage their municipal refuse disposal problems.

To protect against ground water contamination, the University of Delaware has been consigned to evaluate the change of water quality and its effect [illegible] water caused by the landfill operation in that area and its vicinity.

Since the Tybouts Corner sanitary landfill operation started in December 1966, weekly samples have been collected by the University of Delaware to evaluate the water quality change affected by landfill operation. Thirteen ground water observation wells [illegible] I. D. galvanized [illegible] pipes with Johnson stainless steel drive points were driven about 10 to 20 ft below the ground water table

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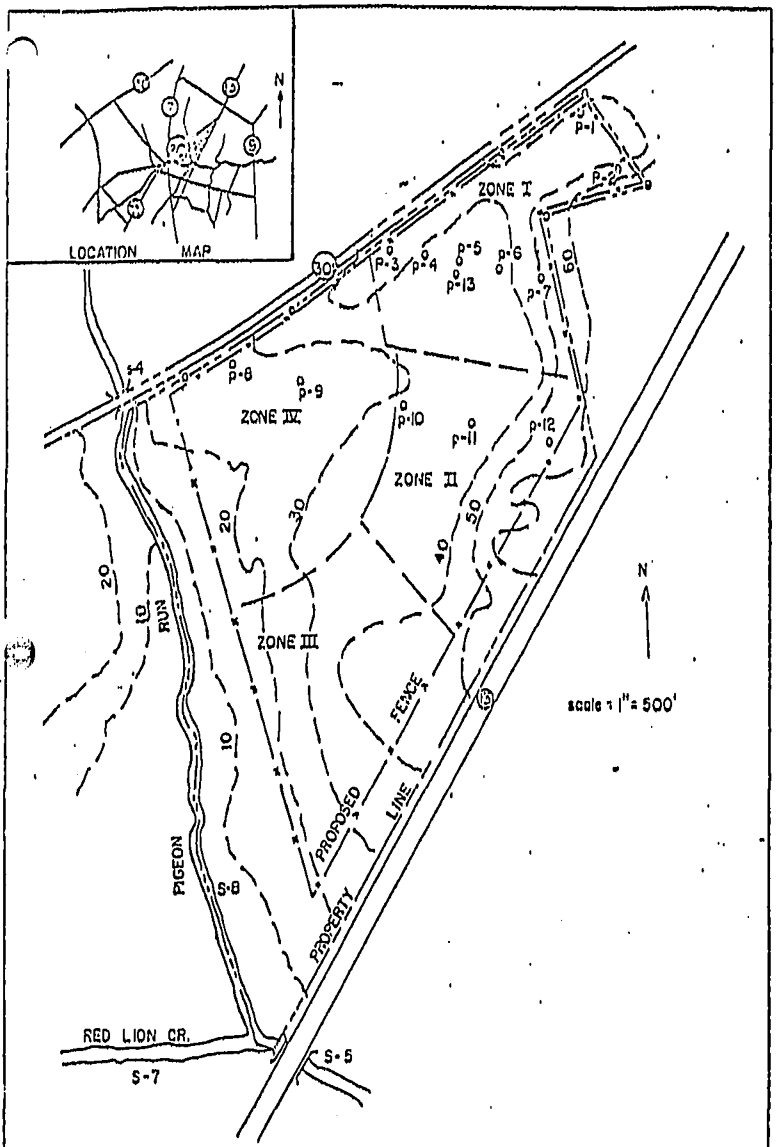

FIG. 12 TOPOGRAPHIC MAP BEFORE LANDFILL PROJECT STARTED
TYBOUTS CORNER SANITARY LANDFILL
NEW CASTLE COUNTY, DELAWARE

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located over the area. Their locations are shown in Figure 12.

In addition, samples were collected from wells of residences along U.S. Highway 13 at the northeast corner adjacent to the landfill. Furthermore, surface water samples from Pigeon Run and Red Lion Creek were also collected for analyses. Sample points are marked on Figure 12.

In regard to the hydrogeologic aspect of landfill operation, Tybouts Corner has no conflict in principles as stated in previous chapters. The site consists of a southwest drained topography with a range in elevation of 45 ft to 75 ft above mean sea level. The direction of ground water movement beneath the site is also southwest where it discharges into Pigeon Run, a tributary of the north branch of the Red Lion Creek.

Surface drainage was very poor before landfill project started. However, upon completion of the filling operation in 1973, the ground surface of the area is suggested to be contoured as Figure 13 to prohibit inundation by any external surface water.

Unconsolidated nonmarine Cretaceous sediments of Potomac Formation underlie the site with the Columbia Formation lying on it. On the basis of twelve borings,

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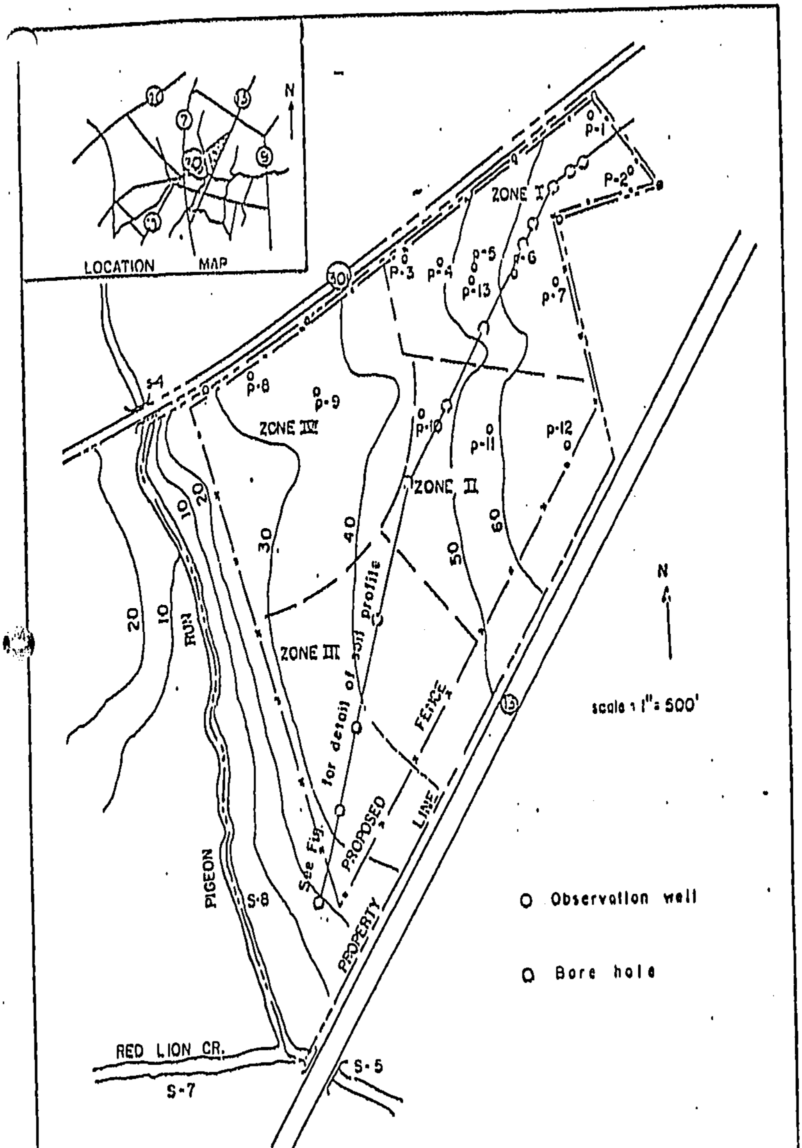

FIG. 13 PROPOSED TOPOGRAPHIC MAP AFTER LANDFILL PROJECT DONE
TYBOUTS CORNER SANITARY LANDFILL
NEW CASTLE COUNTY, DELAWARE

which were made during the initial site investigation to identify soils conditions, a soil profile is prepared as Figure 14 for reference. The predominant soil type is a brown inorganic silty clay with poorly graded gravel which is nonsticky and slightly plastic when dry.

V-2. REFUSE PLACEMENT

The filling of Tybouts Corner sanitary landfill began in December 1969 and was planned to terminate by the end of 1973. All the refuse placed in the area originates in the residential districts of the adjoining communities of northern New Castle County. The refuse is primarily domestic refuse consisting of paper, grass garden trimmings, garbage and miscellaneous inert material.

The area method for sanitary landfill with horizontal compaction is used. At the end of each day's operation, the refuse is usually covered with approximately six inches of soil.

To start the landfilling process, the bulldozer operators cut the original surface down to the final fill-depth, about 2 ft or more above the water table, and expose a working surface. Refuse is dumped in place, and the operators spread and compact it evenly at natural moisture content. As the refuse reaches an elevation about 2 ft

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below the finished grade, a layer of soil is put over it as a final cover. Evergreen seedings are planned to be planted throughout the area finally.

V-3. WATER LEVEL MEASUREMENT

Water table relief is mainly dependent upon the permeability of the material through which recharge occurs or through which the ground water is moving. A ground water high may exist because of a less permeable bed creating a steeper gradient. In general, the more permeable the material, the flatter the configuration of the water table will be.

Ground water under the study area is under water table conditions. Referring to Figure 14, the ground water level varies from 5 ft to 15 ft below the original surface. Its average slope is about 0.005. With this slope, it is obvious that the materials in the study area have a medium low permeability.

In order to approximate both the depth and the possible limits of the fluctuation of the water table beneath the sanitary landfill, the trends of the water table of three observation wells, for which complete records had been kept over the period of study, are plotted as Figure 15. In observation wells P-2 and P-7, water levels were

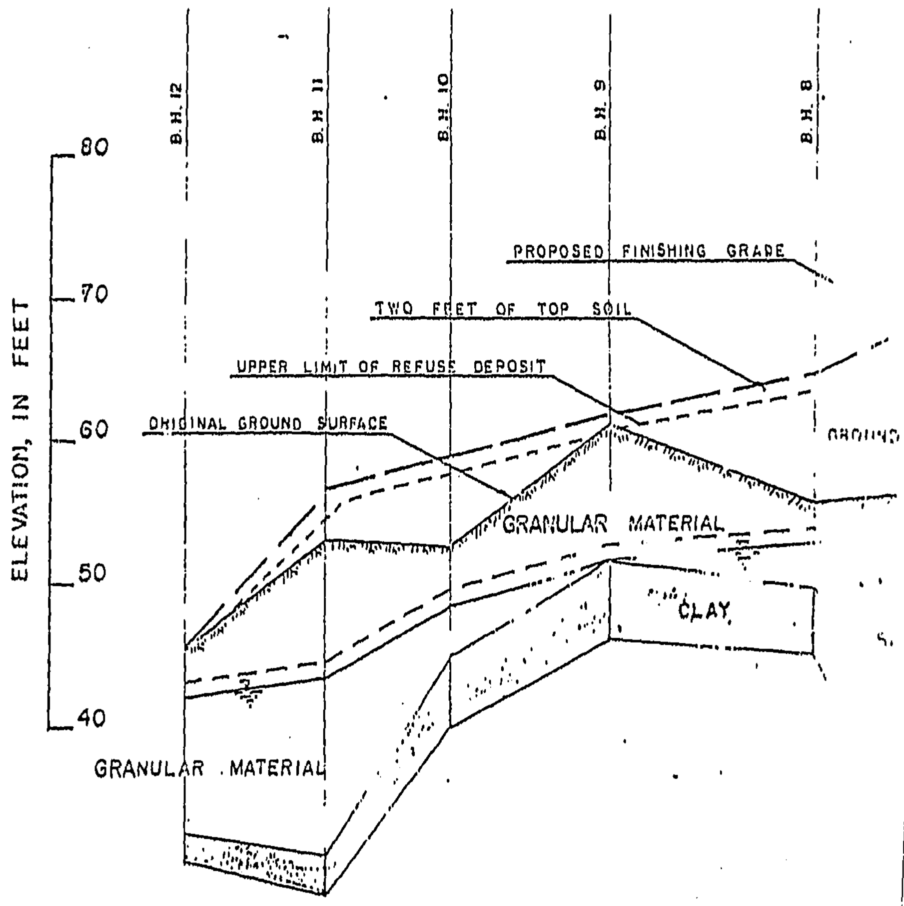

FIG. 14 SOIL PROFILE OF TYBOU
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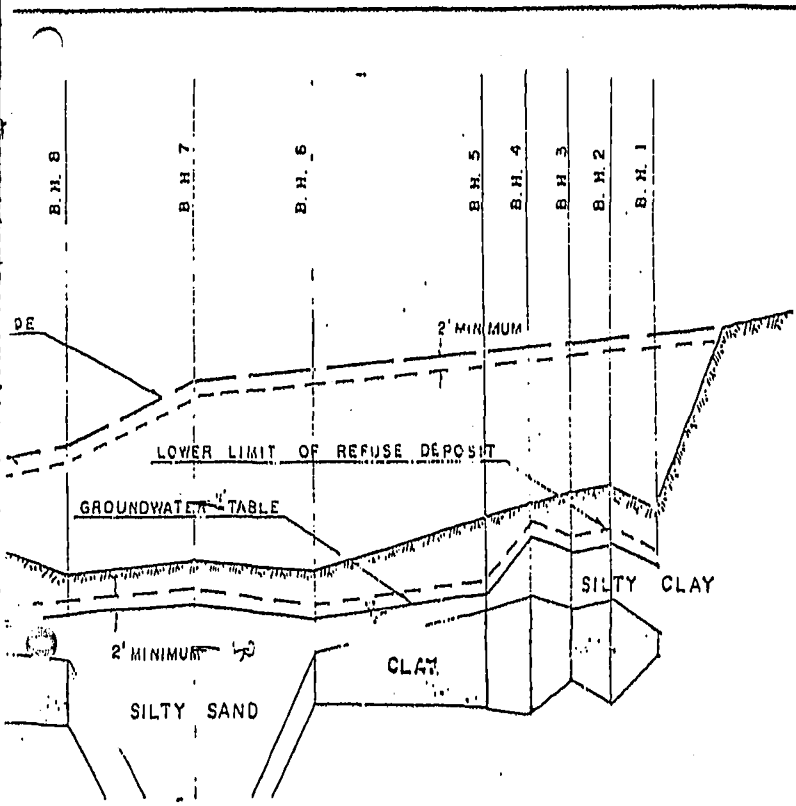

SCALE

H: 1" = 300'

V: 1" = 20'

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COUNTY, DELAWARE

NOV. 18, 1968

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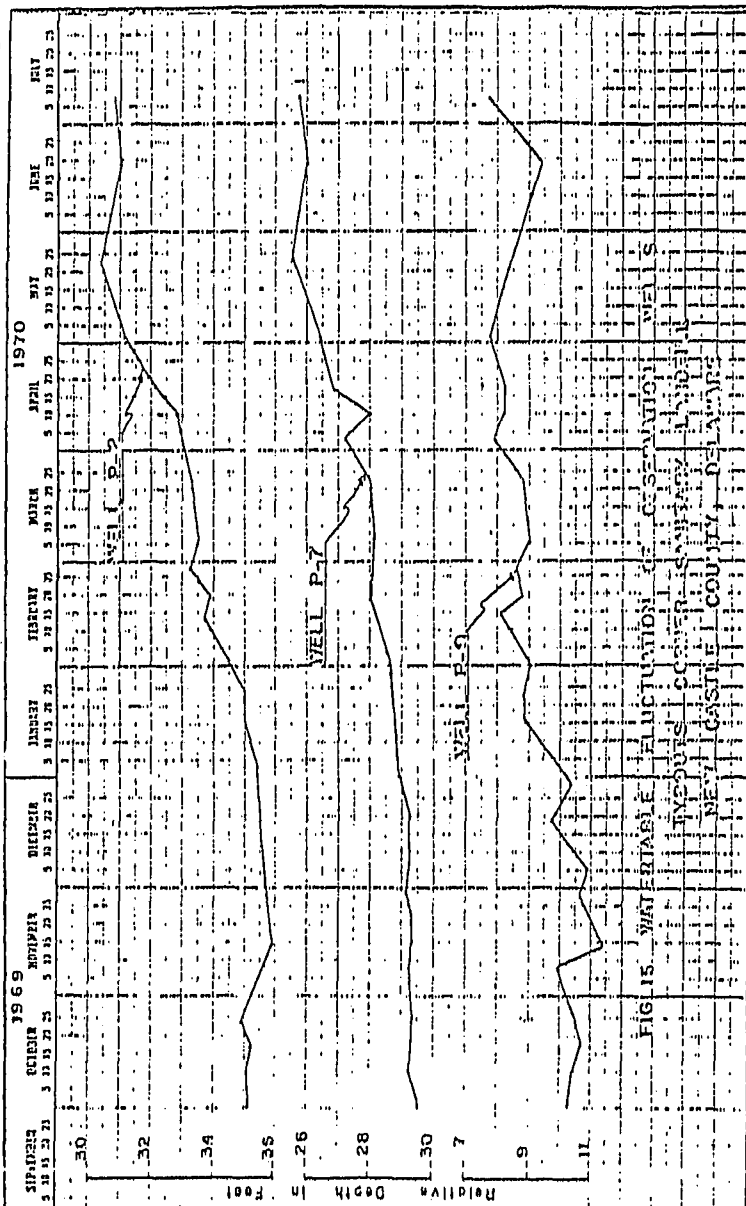

FIG 15 WATER TABLE FLUCTUATION OF OBSERVATION WELLS
TYBOUTS CORNER SANITARY LANDFILL
NEW CASTLE COUNTY, DELAWARE

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recorded after the landfill operation was finished, and observation well P-9 was recorded under a natural undisturbed condition. By examining the trends of the water table shown on Figure 15, it is apparent that water levels rise gradually from January to May. This reflects the seasonal effect of spring recharge in all three wells.

To predict the permeability and other parameters of the study area under the established hydraulic gradients, a pumping test was scheduled to be carried out before the end of July 1970, the termination of the contract which the writer was engaged with the University of Delaware as a research fellow. All the field set-up was ready for the test on July 13, 1970 but the test could not be completed due to the fact that the pump which was furnished by Walton Corporation was incapable of lifting water after the drawdown reached 26.70 ft.

However, referring to the Soil Laboratory Report prepared by Subsurface Engineering, Inc., we can conclude that the coefficients of permeability of the study area are fairly low and it is not expected to develop a significant flow through this material. Table VI presents the test results of coefficient of permeability to clarify the consistency of the material throughout the study area. The tests were run with a constant head from remoulded,

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TABLE VI--Permeability Test For Tybouts Corner Sanitary Landfill

Hole No.	Depth in ft.	Permeability (K) cm/sec (20°C)
BH 11	3- 5	2.1×10^{-7}
	5- 7	5.2×10^{-7}
	7-11	1.7×10^{-8}
BH 10	3- 7	0.8×10^{-7}
	7- 9	2.8×10^{-4}
BH 8	3- 7	1.9×10^{-8}
	7-11	1.4×10^{-8}
	11-15	5.3×10^{-8}

compacted, split spoon, jar samples. The Boring Holes, BH, are shown as Figure 14.

V-4. CHEMICAL QUALITY EVALUATION

To ascertain if there is any appreciable change in quality of ground water down gradient from the landfill, Progress Report of Water Quality Investigation at the Tybouts Corner Sanitary Landfill prepared by Civil Engineering Department, University of Delaware, presents data of the chemical test results periodically with detailed discussion. The chemical parameters analyzed by the Environmental Laboratory are listed in Table VII. Referring to the above mentioned report, some significant parameters are evaluated in the following paragraphs to determine which would best

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TABLE VII.--Chemical Parameters For Leachate Analyses

pH
Nitrates (mg/l)
Chlorides (mg/l)
Specific Conductance (umho/cm)
Total Hardness (mg/l)
Alkalinity (mg/l as $CaCO_3$)
Acidity (mg/l as $CaCO_3$)
B. O. D. (mg/l)
Iron (mg/l)
Orthophosphate (mg/l)

serve as indicators of a general increase in concentration of various chemicals that may be leached from the disposal area.

pH--it has been found that pH determination is a poor indicator. The reason may be because of the large change of hydrogen-ion concentration needed to show a change in pH. For instance, well P-2 which exhibited a noticeable increase in concentration of chloride and other ions showed only a slight increase in pH.

Nitrates--nitrate concentration was high in natural ground water of the landfill area and vicinity. As nitrates were reduced to nitrites under anaerobic conditions, a gradual decline took place in most wells about two months after refuse was covered. This reduction is assumed to be the result of the anaerobic environment that exists probably throughout the fill area.

Chlorides--the chloride-ion determination was the most sensitive parameter used. Therefore, the chloride ion is perhaps the most suitable indicator of leaching from the refuse dump because: it is easily measured, and is not readily absorbed by soil formations; is not altered by biological processes; and considerable quantities may be present in the refuse. Wells P-2, P-7 and P-9, which have continual records during the study period, are plotted diagrammatically of chloride concentration change at sampling points. The trend of chloride concentration change of P-2 as Figures 16 and 17 indicates a steady increase in chloride concentration. No significant change in P-7 may be due to the topo-

? [illegible]

graphic effect of higher piezometric head at the well site with a down gradient flow toward south west direction to Pigeon Run. Based on about 12 months of water quality analyses of ground water in the landfill area, since ground water movement is fairly slow, it is hard to detect any water quality change in P-9 so far, after the completion of refuse dump in Zone I area (Figure 12).

Specific Conductance--specific conductance, which is indicative of the total concentration of dissolved ions, is a valuable tool in comparing ground water qualities. Although specific conductance does not indicate which ions are present in the sampler, it demonstrated relatively marked quality changes through the fill area. The long term trend of specific conductance data of the water samples

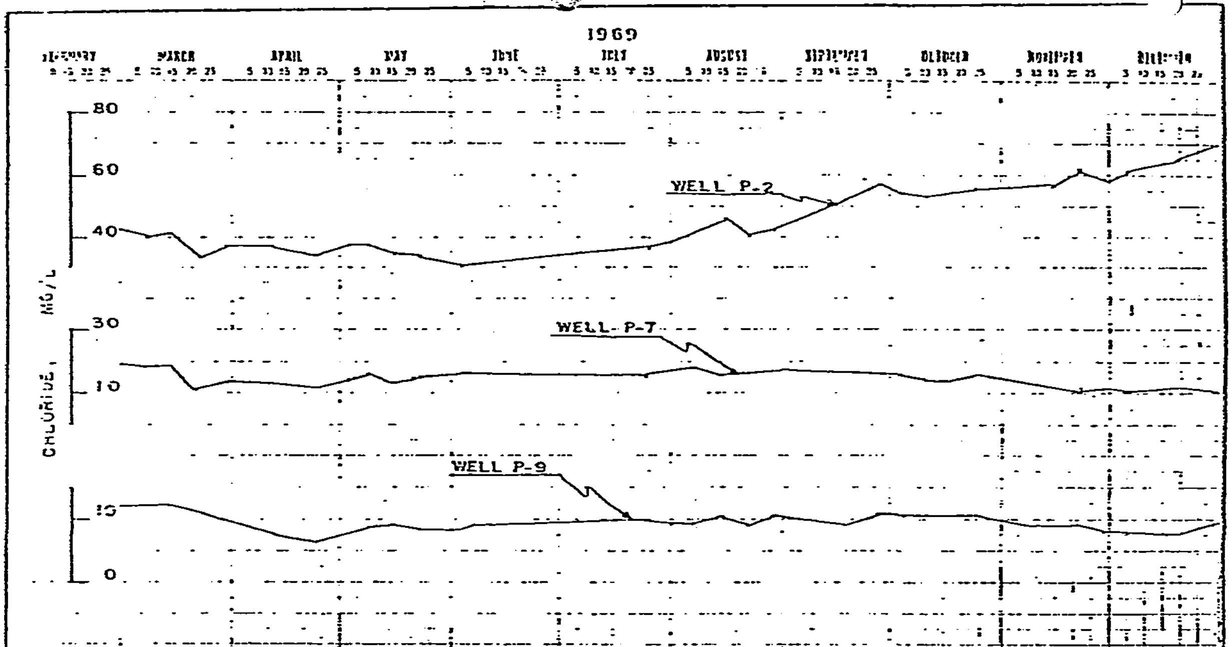

FIG.15 DIAGRAMS OF CHLORIDE CONCENTRATION CHANGE AT SAMPLING POINTS TYBOUTS CORNER SANITARY LANDFILL, NEW CASTLE COUNTY

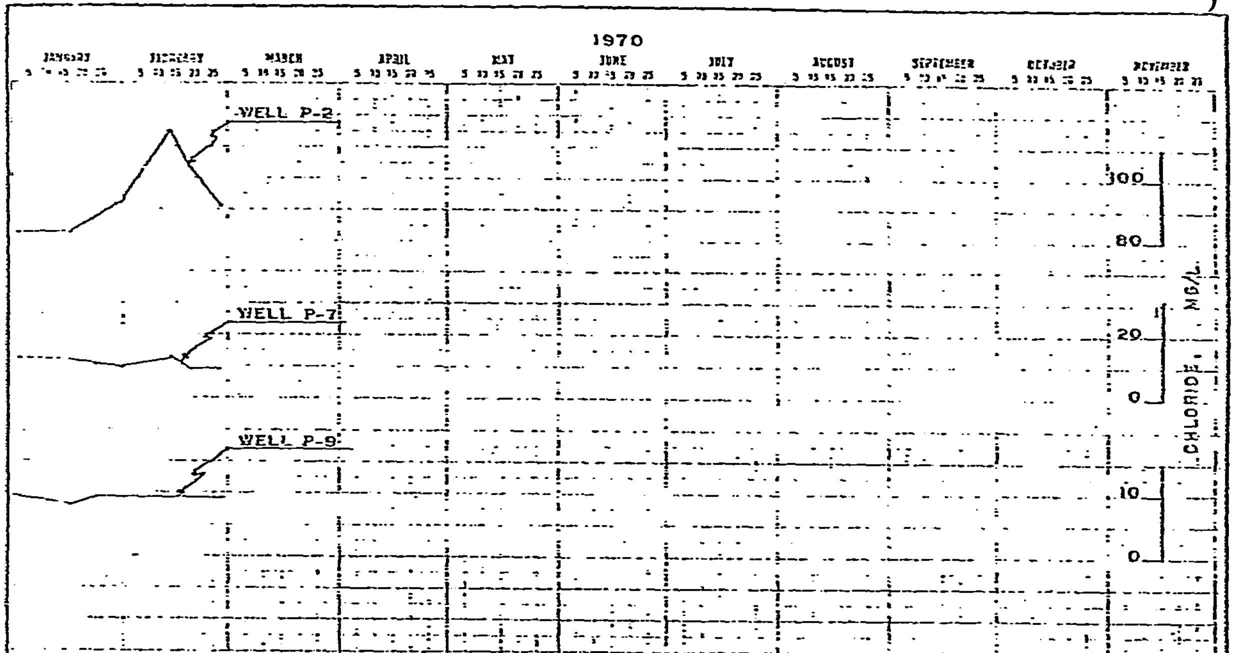

FIG.17 DIAGRAMS OF CHLORIDE CONCENTRATION CHANGE AT SAMPLING POINTS
TYBOUTS CORNER SANITARY LANDFILL, NEW CASTLE COUNTY, DELAWARE

followed the pattern of chloride data.

Other Parameters--during such a short study period, the other parameters, which are listed in Table VII, did not give a good indication of leachate movement. Continuing studies of chemical analyses for at least three more years is required to evaluate their specified characteristics in regard to leachate contamination and movement.

Water samples were taken from a few private residences along U.S. Highway 13 at the northeast corner about 200 ft from the landfill site. With this distance and location, the landfill is not expected to have any influence because of the direction of ground water movement. Test reports of house samples indicated no effect by the landfill operation so far. Stream sample records of Pigeon Run and its tributaries also did not show up any quality change due to the landfill.

With the data available at this moment, some leachate has been introduced into the ground water which can be detected by chlorides, 115 mg/l in February 1970 in well P-2, and specific conductance, 250 umho/cm on April 25, 1969. But the levels of contaminants are quite low compared with their hazardous limits of 250 mg/l and 1,700 umho/cm, respectively (21).

CHAPTER VI

SUMMARY AND CONCLUSIONS

VI-1. GENERAL

1. The water balance study for Delaware indicates that there is a surplus of water from November to March of the next year. Every January, there is on the average about 9 inches of water available for ground-water replenishment. This is the maximum monthly surplus water for the year. Thus, special attention must be paid to the selection of a sanitary landfill site due to this water surplus.

2. With regard to the geologic selection of a landfill site for northern Delaware, the Columbia formation of the Coastal Plain, which does not exceed 20 ft with soil that contains about 50 percent sand and approximately equal amounts of clay or silt and has a relatively impermeable bottom, would be an ideal site for a landfill operation. The Piedmont Province of the study area is not recommended for landfill projects.

This is [illegible] There are [illegible] Columbia is [illegible]

3. With respect to the hydrologic conditions, Delaware is a humid area. In New Castle County, the

excessive moisture in a landfill will saturate about 9 ft of refuse each year. Soon after the entire landfill reaches saturation, the excessive moisture runs down gradient freely to the underlying ground water aquifer and thereby pollutes the aquifer. Hence, the landfill in the study area should be located at a discharge zone which enables us to manage the pollution problem when this happens.

4. In the operational consideration of selecting a sanitary landfill site, a topographic survey, boring tests with soil profile and ground water elevation, and ground water samples should be made before starting the operation. Meanwhile, field-test cells are recommended to be installed in the county's future landfill projects for reliable physical and chemical information collection.

5. After the completion of a landfill, the slope of the fill surface should be at least one percent to assure drainage. Shallow parabolic grass channels with a capacity of 10-yr storm frequency are recommended to prevent ponding and excessive seepage into the fill.

VI-2. TYBOUTS CORNER SANITARY LANDFILL

1. In the hydrogeologic aspect of landfill operation, Tybouts Corner has no conflict with the principles as stated in this paper.

2. The coefficients of permeability of the study area are fairly low and it is not expected that significant flow through the soil in the project area will develop.

3. The chloride ion is the most suitable indicator of the concentration of the leachate.

4. Water samples from test wells in the project area to February 1970 tend to bear out that some leachate has been introduced into the ground water. However, the level of contaminants is very low compared with the hazardous limits.

5. Test reports of water samples collected from the houses adjacent to the landfill site indicated no effect by the landfill operation up to July 1970.

6. Upon the completion of the filling operation of the Tybouts Corner landfill project, the ground surface of the area is suggested to be contoured as shown on Figure 13 to prohibit inundation.

VI-3. SUGGESTIONS FOR FUTURE USE OF THE SITE

1. After the fill is completed in accordance with procedures previously outlined, the site can be utilized for many worthwhile purposes. It is desirable that the ultimate use be known ahead of time so that proper planning

can be effectuated in operating the sanitary landfill. Records of what happens during the fill operation have to be taken to adjust the final decision as to the future plans.

2. In planning the use of the site, physical factors such as the susceptibility to flood, the topographic relief, and the subsurface conditions must be considered.

3. In terms of over-all community development, with extensive deposits of sand and gravel suitable for use as construction materials, the site might be suited to development of an industrial park as well as a park or playground, which is by far the greatest percentage of how filled sites are used.

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